Project Report: Prebiotic Organics from Space

Project Investigators:	***Louis Allamandola , Max Bernstein , Scott Sandford***

Project Progress

We have made progress in all three focus areas pertinent to our task: interstellar prebiotic chemistry, observational astrobiology, and prebiotic membrane studies. In the prebiotic interstellar chemistry arena we have completed studies of the infrared (IR) properties of neutral and ionized polycyclic aromatic hydrocarbons (PAHs) frozen in realistic interstellar water ice analogs and are now preparing these results for publication. Water is a common interstellar and Solar System ice. These spectra will be used to interpret data taken with NASA's new Spitzer IR telescope. We have found a remarkable result. When frozen in water, PAHs are readily ionized and stabilized as ions as long as the ice is kept below about 50K. This realization will have far–reaching impact on our understanding of extraterrestrial ice physics and spectroscopy.

We have studied the interstellar photostability of amino acids, nitriles, and precursor molecules in these ice analogs and compared photochemistry with proton bombardment processes.

In the observational arena we believe we have detected evidence for deuterated interstellar PAHs, making an additional link between our ongoing lab studies of PAHs and their photoproducts with important biogenic species in meteorites. This also bears on biomarker reliability. Scott Sandford, a member of this team, has spearheaded the concept development and proposal submission for the first mission dedicated to Astrobiology, ABE the Astrobiology Explorer. Lastly, we have also submitted several proposals to Spitzer to track organic species in the Milky Way and other galaxies.

Lastly, concerning primitive membranes, Dr. Charles Apel has become a member of our team. In the short time he has been with us he has assembled the equipment necessary and already started investigating primitive membrane systems.

Highlights

- We have found the remarkable result that when PAHs are frozen in Solar System and interstellar water ice analogs they are readily ionized and stabilized as ions as long as the ice is kept below about 50K. Because this can account for unusual ice coloring, enhanced vaporization, and unexpected spectroscopic signatures, this realization will have far–reaching impact on our understanding of extraterrestrial ices.
- We have shown the mass spectral envelope of material formed by ultraviolet (UV) photolysis of realistic interstellar ice analogs bears a very close resemblance to the low mass envelope of interplanetary dust particle (IDP) organics, suggesting the interstellar ice formation mechanism may have played some role in the formation of the molecules in IDPs.

Roadmap Objectives

- ***Objective No. 1.1:*** Models of formation and evolution of habitable planets
- ***Objective No. 3.1:*** Sources of prebiotic materials and catalysts
- ***Objective No. 3.4:*** Origins of cellularity and protobiological systems
- ***Objective No. 4.3:*** Effects of extraterrestrial events upon the biosphere
- ***Objective No. 7.1:*** Biosignatures to be sought in Solar System materials
- ***Objective No. 7.2:*** Biosignatures to be sought in nearby planetary systems

Mission Involvement

*Mission Class**	*Mission Name (for class 1 or 2) OR Concept (for class 3)*	*Type of Involvement***
1	SOFIA	Planning Support,Data Analysis,Background Research,Instrument/Payload Development,Research or Analysis Techniques
1	SIRTF/SPITZER	Planning Support,Data Analysis,Background Research,Instrument/Payload Development,Research or Analysis Techniques
1	Stardust	Co–Investigator,Science Team Member,Planning Support,Data Analysis,Background Research,Instrument/Payload Development,Research or Analysis Techniques
2	ABE	

		Project Investigator,Co−Investigator,Science Team Member,Planning Support,Data Analysis,Background Research,Instrument/Payload Development,Research or Analysis Techniques
2	CSSR − Comet Surface Sample Return	Co−Investigator,Science Team Member,Planning Support,Data Analysis,Background Research,Instrument/Payload Development,Research or Analysis Techniques

* Mission Class: Select 1 of 3 Mission Class types below to classify your project:
1. Now flying OR Funded & in development (e.g., Mars Odyssey, MER 2003, Kepler)
2. Named mission under study / in development, but not yet funded (e.g., TPF, Mars Lander 2009)
3. Long−lead future mission / societal issues (e.g., far−future Mars or Europa, biomarkers, life definition)

** Type of Involvement = Role / Relationship with Mission
Specify one (or more) of the following: PI, Co−I, Science Team member, planning support, data analysis, background research, instrument/payload development, research or analysis techniques, other (specify).

These are all NASA missions.

Cross Team Collaborations

We collaborate with Dr. Jason Dworkin , a member of the NASA Goddard Astrobiology Team. As this is the first year of their program, we are at the planning experiment stage.